BOTANY

Plants and Light.[1]—A paper of Professor Julius Wiesner, dealing with the quantitative and qualitative light-relations of plants, is of particular interest to American botanists, since it records the results of observations made in the United States.

Some twelve years ago, Professor Wiesner, who fills the chair of plant physiology at the University of Vienna, led by his studies on the relation of light-intensity and heliotropism on the one hand, and that of light-intensity and carbon-assimilation on the other, inaugurated a series of observations on the effect of light-intensity on the form of plants. The discovery that the process by which the plant assumes its form depends on the influence of rays different from those which take part in photosynthesis, opened an entirely new field of investigation, and rendered the measurement of the highly refractive rays a necessity.

Various methods answering the latter purpose existed, the principal one being that of Bunsen and Roscoe, in which a standard photographic paper is exposed to light; the tone obtained is then compared with a standard black. In the course of the investigations various improvements in the method, such as a substitution of a color-scale for the standard black, suggested themselves. Detailed accounts of method and improvements are scattered through Professor Wiesner's numerous papers, but may be found more especially in his earlier publications.[2]

These measurements of light-intensity are based on the law of Bun-

[1] Wiesner, J. "Untersuchungen über den Lichtgenuss der Pflanzen im Yellowstone Gebiete und in anderen Gegenden Nordamerikas. Photometrische Untersuchungen auf pflanzenphysiologischem Gebiete. (V. Abhandlung.)" *Sitzungsber. d. k. Akad. d. Wiss. in Wien, mathem.-naturw. Klasse*, vol. 114, pt. 1, Feb., 1905.

[2] Wiesner, J. "Photometrische Untersuchungen auf pflanzenphysiologischem Gebiete. (I. Abhandlung.)" *Sitzungsber. d. k. Akad. d. Wiss. in Wien, mathem.-naturw. Klasse*, vol. 102, pt. 1, June, 1893; and "Untersuchungen über den Lichtgenuss der Pflanzen mit Rücksicht auf die Vegetation von Wien, Cairo und Buitenzorg (Java). Photometrische Untersuchungen auf pflanzen-physiologischem Gebiete. (II. Abhandlung.)" *Sitzungsber. d. k. Akad. d. Wiss. in Wien, mathem.-naturw. Klasse*, vol. 104, pt. 1, July, 1895.

sen and Roscoe: "Identical colors of normal papers exposed to light indicate identical products of light-intensity and time." Any tone may therefore be produced by any intensity, but reduced to a definite time, can correspond to one definite (chemical) light-intensity only.

For purposes of measurement of chemical light-intensity, a darkening of the normal paper corresponding to the normal black and brought about in one second, is considered as the unit. If, for instance, the normal black is obtained on the normal paper in 2 seconds, the light-intensity equals $\frac{1}{2}$.

By aid of this method, the light-intensity at any place, on plains, in the vicinity of buildings or groups of trees, inside of the tree-crown, in the shade, in greenhouses, in rooms, etc., can be measured. One can determine the part of the total daylight received by a plant ("relatives Lichtgenuss"), and compare this with the amount of light which, on standard paper, forms the normal tone in one second ("absolutes Lichtgenuss"). In this manner the relation between light-intensity and bud development, form of plant-body, budding and the shedding of leaves was determined. It was found that certain trees use more light than do others, that the portion of total daylight used by trees varies with the time of day, that for some trees this portion is greatest at noon, that for others it is least at the same hour.

Observations were made in Central Europe chiefly, but at times extended to 6° S. lat. and 79° N. lat. This included plains and mountain ranges in temperate climates (Central Europe), arctic regions (Spitzbergen), tropical (Java), and semitropical regions (Egypt). The extension of the experiments to high altitudes remained, more particularly a study of the change in relation between light-intensity and the amount of light used by the plant under the influence of increased altitude.

The mountainous regions of Europe do not offer a desirable field for such investigations, on the one hand because the tree-limit is reached comparatively soon, on the other because extensive plateaus at a considerable elevation above sea-level and easy of access, are lacking. Besides, on account of the numerous cañons and resulting sheltered and exposed places, introducing a vegetation of other altitudes, mixed with regressions, and causing a descent and ascent of species, the continental mountain ranges do not recommend themselves for this purpose.

The extensive American plateaus, however, offer the advantage of a gradual slope from the Atlantic to the Rocky Mountains. This is true in particular of a region beginning with the Missouri valley and

ending at the head-waters of the Yellowstone. One of the chief advantages which this section offers for photometric investigations lies in the very gradual rise of the ground from east to west, beginning with an elevation of but a few hundred meters and finally attaining a height of more than 3000 meters.

Professor Wiesner made use of these natural conditions when, in 1904, he visited the United States. Measurements were made at various points, such as Niagara, St. Paul, Colorado Springs, and Pike's Peak, but the main part of the investigation was carried on in, or in the immediate vicinity of, the Yellowstone Park, during the latter part of August and the early part of September. The medium for study was afforded by 24 herbaceous and 17 woody species.

It was found that an increase in altitude not only means an increase in the intensity of the total daylight, but also an increase in the intensity of the direct (parallel) rays as compared to the intensity of the diffused light. Earlier work[1] had shown that the amount of total daylight used by arctic plants increases as they approach the pole. Measurements in the United States showed that plants ascending to higher altitudes behave in the same manner, but only up to a certain altitude, beyond which a constantly diminishing portion of the total light is used. Evidently the increased intensity of the direct sunlight in high altitudes is not favorable to trees, as shown by the fact that plants, which at lesser elevations do not shed their leaves in summer (Hitzelaubfall), do so at greater altitudes.

A protection against the very intense direct rays is found in the cypress- (pyramid-) shape, adopted by trees in high altitudes (*Pinus murrayana* in the Yellowstone Park). Thus the rays of the midday sun strike the tree at a small angle and hence become much weakened before penetrating the crown. Trees which reach down as far as subtropical regions also have a pyramid-shaped crown, as for instance the cypress, and for the same reason, since this shape protects the trees from the too intense light from the south.

These investigations open a comparatively new field which those who live under favorable conditions will doubtless hasten to enter. The various agricultural experiment stations, for instance, could easily take up such work. In a few years there would be produced

[1]Wiesner, J. "Untersuchungen über den Lichtgenuss der Pflanzen im arktischen Gebiete. Photometrische Untersuchungen auf pflanzenphysiologischem Gebiete. (III. Abhandlung.)" *Sitzungsber. d. k. Akad. d. Wiss. in Wien, mathem.-naturw. Klasse,* vol. 109, pt. 1, 1900.

an accumulation of figures the interpretation of which would be of both scientific and practical value, being applicable to physiological and horticultural problems alike.

H. Hus

Campbell's Mosses and Ferns.[1]—This new edition of a widely used work is so much enlarged and revised as to deserve recognition as such on its title page, rather than to have it announced only in the "Preface to the Second Edition." The extent of the new matter is shown in the increase of the fourteen chapters constituting the body of the former book, by 54 pages, the addition of two entirely new chapters containing about 29 pages, and the increase of the text figures from 266 to 322. The great activity of investigators in this field during the ten years since the first edition was issued, is indicated by the addition of about 180 titles to the bibliography, while some papers referred to in the new text appear to be omitted from the list.

The portion of the text devoted to the Bryophyta is not greatly modified. The changes consist chiefly in the suppression of a few sentences here and there, and the occasional addition of a paragraph or two; *e. g.*, there is a new account of the spermatogenesis of Marchantia based on Ikeno's work. The most striking change is the elevation of the Anthocerotaceæ from the rank of a subordinate "Group" under the Hepaticæ to that of the Class Anthocerotes coördinate with the Hepaticæ and the Musci. This view is not new, for the same disposition of the group was formally made by Howe in 1899, and was followed by Professor Campbell in his *University Text-book* (1902), though neither in the latter work nor here does the author mention the fact. Little new evidence on this question is now brought forward, for the increase in the space devoted to the Anthocerotes is due chiefly to the addition of three new figures. The change has come about through the giving of greater weight to the well known peculiarities of the group, and it is to be welcomed as emphasizing the importance of these plants in phylogeny. It is a pleasure to note that the author has at last begun to adopt a consistent plan of designating orders and families in accordance with the best present usage, though it is unfortunate that he still clings to the clumsy and anomalous terms Jungermanniales Anacrogynæ and J. Acrogynæ. Incidentally

[1] Campbell, D. H. *The Structure and Development of Mosses and Ferns* (*Archegoniatæ*). New York, The Macmillan Co., 1905. 8vo, vii + 657 pp., illus.